

(19) World Intellectual Property Organization
International Bureau



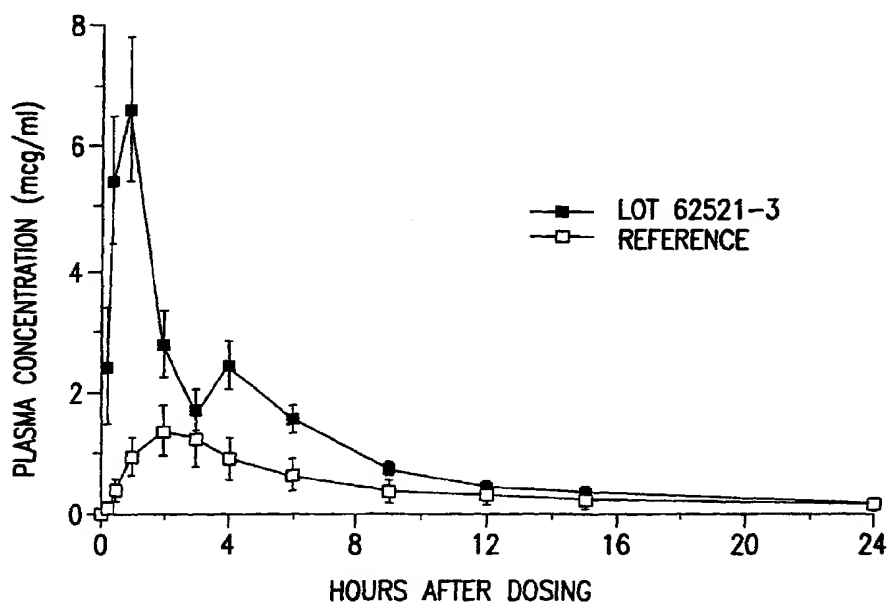
(43) International Publication Date
21 December 2000 (21.12.2000)

PCT

(10) International Publication Number
WO 00/76482 A1

- (51) International Patent Classification⁷: **A61K 9/48**,
A61P 3/04 Meadow Circle, Lake Bluff, IL 60044 (US). **HANSRANI, Pawan**; 87 Chestnut Terrace, Buffalo Grove, IL 60089 (US).
- (21) International Application Number: PCT/US00/15717
- (22) International Filing Date: 8 June 2000 (08.06.2000)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
09/330,589 11 June 1999 (11.06.1999) US
- (71) Applicant: **ABBOTT LABORATORIES** [US/US];
D377/AP6D, 100 Abbott Park Road, Abbott Park, IL
60064-6050 (US).
- (72) Inventors: **LIU, Rong, (Ron)**; 973 Knowles Road,
Gurnee, IL 60031 (US). **PAN, Qinghai**; 12589 West
- (74) Agents: **SICKERT, Dugal, S. et al.**; D377/AP6D, 100
Abbott Park Road, Abbott Park, IL 60064-6050 (US).
- (81) Designated States (*national*): CA, JP, MX.
- (84) Designated States (*regional*): European patent (AT, BE,
CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,
NL, PT, SE).
- Published:
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: NOVEL FORMULATIONS COMPRISING LIPID-REGULATING AGENTS



(57) Abstract: The present invention is directed to a semi-solid formulation comprising a lipid-regulating agent. Said formulation is prepared by solubilizing said lipid-regulating agent in one or more liquid components to form a clear liquid solution, then solidifying said solution by adding one or more solid or semi-solid components to said solution to form a semi-solid formulation. Said formulation can melt or dissolve upon mixing with a bulk aqueous medium. The resulting formulation results in an increase in drug solubility and oral bioavailability, and an improved dissolution rate.

Novel Formulations Comprising Lipid-Regulating Agents

Field of the Invention

5

The present invention relates to novel formulations comprising lipid-regulating agents.

10

Background of the Invention

15

2-[4-(4-chlorobenzoyl)phenoxy]-2-methyl-propanoic acid, 1-methylethylester, also known as fenofibrate, is representative of a broad class of compounds having pharmaceutical utility as lipid regulating agents. More specifically, this compound is part of a lipid-regulating agent class of compounds commonly known as fibrates, and is disclosed in U.S. Patent No. 4,058,552.

20

Fenofibrate has been prepared in several different formulations, c.f., U.S. Patent No. 4,800,079 and U.S. Patent No. 4,895,726. U.S. Patent No. 4,895,726 discloses a co-micronized formulation of fenofibrate and a solid surfactant.

25

30

35

U.S. Patent No. 4,961,890 discloses a process for preparing a controlled release formulation containing fenofibrate in an intermediate layer in the form of crystalline microparticles included within pores of an inert matrix. The formulation is prepared by a process involving the sequential steps of dampening said inert core with a solution based on said binder, then projecting said fenofibrate microparticles in a single layer onto said dampened core, and thereafter drying, before said solution based on said binder dissolves said fenofibrate

microparticles, and repeating said three steps in sequence until said intermediate layer is formed.

European Patent Application No. EP0793958A2 discloses a process for producing a fenofibrate solid dosage form utilizing fenofibrate, a surface active agent and polyvinyl pyrrolidone in which the fenofibrate particles are mixed with a polyvinyl pyrrolidone solution. The thus obtained mixture is granulated with an aqueous solution of one or more surface active agents, and the granulate thus produced is dried.

PCT Publication No. WO 82/01649 discloses a fenofibrate formulation having granules that are comprised of a neutral core that is a mixture of saccharose and starch. The neutral core is covered with a first layer of fenofibrate, admixed with an excipient and with a second microporous outer layer of an edible polymer.

U.S. Patent No. 5,645,856 describes the use of a carrier for hydrophobic drugs, including fenofibrate, and pharmaceutical compositions based thereon. The carrier comprises a digestible oil and a pharmaceutically-acceptable surfactant component for dispersing the oil in vivo upon administration of the carrier, which comprises a hydrophilic surfactant, said surfactant component being such as not to substantially inhibit the in vivo lipolysis of the digestible oil.

Gemfibrozil is another member of the fibrate class of lipid-regulating agents. U.S. Patent No. 4,927,639 discloses a disintegratable formulation of gemfibrozil providing both immediate and sustained release, comprising a tablet compressed from a mixture of a first and second granulation, and a disintegration excipient operable to

effect partial or complete disintegration in the stomach. The first granulation comprises finely divided particles of pure gemfibrozil granulated with at least one cellulose derivative, and the second granulation comprises finely divided particles of pure gemfibrozil granulated with a pharmaceutically-acceptable water soluble or insoluble polymer which are then uniformly coated with a pharmaceutically-acceptable (meth)acrylate copolymer prior to admixture with the first granulation. The first and second granulations are present in the final composition in a ratio of from about 10:1 to about 1:10.

U.S. Patent 4,925,676 discloses a disintegratable gemfibrozil tablet providing both immediate and enteric release, which is compressed from a mixture of a first granulation of gemfibrozil with at least one acid-disintegratable binder, and a second granulation formed from the first granulation, but regranulated or coated with an alkali-disintegratable formulation of at least one substantially alkali-soluble and substantially acid-insoluble polymer.

Another class of lipid-regulating agents are commonly known as statins, of which pravastatin and atorvastatin are members. U.S. Patents 5,030,447 and 5,180,589 describe stable pharmaceutical compositions, which when dispersed in water have a pH of at least 9, and include a medicament which is sensitive to a low pH environment, such as pravastatin, one or more fillers such as lactose and/or microcrystalline cellulose, one or more binders, such as microcrystalline cellulose (dry binder) or polyvinylpyrrolidone (wet binder), one or more disintegrating agents such as croscarmellose sodium, one or more lubricants such as magnesium stearate and one or more basifying agents such as magnesium oxide.

It is an object of the present invention to provide formulations of lipid-regulating agents having enhanced bioavailability when compared to commercially available formulations.

Summary of the Invention

The present invention is directed to a semi-solid formulation comprising a lipid-regulating agent, a liquid component, and a solid or semi-solid component.

Said formulation is prepared by solubilizing said lipid-regulating agent in one or more liquid components to form a clear liquid solution, then solidifying said solution by adding one or more solid or semi-solid components to said solution to form a semi-solid formulation. Said formulation can melt or dissolve upon mixing with a bulk aqueous medium. The resulting formulation results in an increase in drug solubility and oral bioavailability, and an improved dissolution rate.

The formulation may be administered directly, diluted into an appropriate vehicle for administration, encapsulated into soft or hard gelatin capsules for administration, or administered by other means obvious to those skilled in the art.

Brief Description of the Drawings

Figures 1 and 2 are graphs showing the plasma concentration in fasted dogs of the formulation of Example 1 and 2, respectively, and a commercial, reference compound

Detailed Description of the Invention

The bulk lipid-regulating agent may be prepared by any available method, as for example the compound fenofibrate
5 may be prepared by the procedure disclosed in U.S. Patent No. 4,058,552, or the procedure disclosed in U.S. Patent No. 4,739,101, both herein incorporated by reference.

The composition comprising the lipid-regulating agent
10 is prepared by solubilizing said lipid-regulating agent in one or more liquid components to form a clear liquid solution, then solidifying said solution by adding one or more solid or semi-solid components to said solution to form a semi-solid formulation. Said formulation can melt or
15 dissolve upon mixing with a bulk aqueous medium.

The delivery system of the present invention results in increased solubility and bioavailability, and improved dissolution rate of the lipid-regulating agent.

20

The selection of liquid components is based on the component's ability to solubilize fenofibrate. Suitable liquid components thus include, for example, any pharmaceutically-acceptable liquid surfactants, solvents and
25 oils. Examples of such components includes

Pharmaceutically-acceptable solvents include oily or non-aqueous solvents, for example, acetylated monoglycerides, propylene glycol fatty acid esters,
30 including but not limited to propylene glycol dicaprylat/dicaprate, propylene glycol laurate, propylene glycol dicaprylate, and propylene glycol mono and dicaprylate; and unsaturated polyglycolysed glycerides, for example, Labrafil M 2125CS Gattefosse). Preferred
35 acetylated monoglycerides include, for example, Myvacet 9-

08, Myvacet 9-45 and Myverol 18-92 (Eastman Chemicals);
Lauroglycol, a propylene glycol monolaurate (Gattefosse);
and Capmul PG 8, a propylene glycol mono and dicaprylate
available (Abitec).

5

Other solvents include, for example, pharmaceutically-
acceptable alcohols such as, for example, propylene glycol;
ethanol; transcitol (Gattefosse); glycerol; and polyethylene
glycol 200, polyethylene glycol 300, and polyethylene glycol
10 400 (Union Carbide).

Other solvents include, for example, pharmaceutically
acceptable oils such as, for example, mineral oil or a
vegetable oil including, safflower oil, olive oil,
15 fractionated coconut oil, for example, mixed triglycerides
with caprylic acid and capric acid (Miglyol 812, Huls).

Pharmaceutically-acceptable surfactants include non-
ionic surfactants such as mono fatty acid esters of
20 polyoxyethylene sorbitan, for example, polyoxyethylene (20)
sorbitan monooleate (Tween 80), polyoxyethylene (20)
sorbitan monostearate (Tween 60), polyoxyethylene (20)
sorbitan monolaurate (Tween 20) (Sigma); anionic surfactants
such as, for example, sodium lauryl sulfate; polyoxyethylene
25 castor oil derivatives, for example polyoxyethyleneglycerol
triiricinoleate or polyoxyl 35 castor oil (Cremophor EL,
BASF); and Vitamin E TPGS (d-alpha -tocopheryl succinate).

The solid or semi-solid component primarily functions as a
30 solidifying agent, however, depending upon the characteristics
of such component, such component may also assist as a
solubilizer. Examples of such components include polypropylene
glycol; polyethylene glycol (for example polyethylene glycol
1450, polyethylene glycol 3350, polyethylene glycol 6000, and
35 the like (Union Carbide); polyoxyethylene castor oil

derivatives, for example polyoxyethylene glycerol tricinoleate or polyoxyl 35 castor oil (Cremophor EL, BASF), polyoxyethylene glycerol oxystearate (Cremophor RH 40 (polyethylene glycol 40 hydrogenated castor oil) or Cremophor RH 60 (polyethyleneglycol 5 60 hydrogenated castor oil), BASF); saturated polyglycolized glycerides, for example, Gelucire 35/10, Gelucire 44/14 or Gelucire 53/10 and the like Gattefosse); polyethylene polypropylene glycol (Poloxamer 68 and Poloxamer 127 (BASF); Vitamin E TPGS (d-alpha -tocopheryl polyethylene glycol 1000 10 succinate, Eastman Chemical).

Other pharmaceutically-acceptable excipients may be added to the formulation prior to forming the desired final product. Suitable excipients include, for example, antioxidants (for 15 example, ascorbic acid, BHA (butylated hydroxyanisole), and vitamin E.

The resulting composition comprising the lipid-regulating agent may be dosed directly for oral 20 administration, diluted into an appropriate vehicle for oral administration, filled into soft or hard capsules for oral administration, or delivered by some other means obvious to those skilled in the art. The said liquid can be used to improve the oral bioavailability, and increase the half-life 25 and solubility of said lipid-regulating agent.

The invention will be understood more clearly from the following non-limiting representative examples:

Example 1

Myvacet 9-08 (Eastman Chemical) (402 mg) was mixed with
5 propylene glycol laurate (Gattefosse) (67 mg). To this
solution was added fenofibrate (Sigma) (67 mg) and the
resulting mixture was mixed well until the fenofibrate
dissolved. The resulting solution was heated to about 45-
50°C. To the solution was added Vitamin E TPGS (Eastman
10 Chemical) (134 mg) and the resulting mixture was stirred
until a clear solution obtained. The resulting solution
(670 mg) was filled into hard gelatin capsules while the
solution was still warm and in a liquid state. Each capsule
contained 67 mg of fenofibrate.

Example 2

Capmul PG-8 (Abitec) (6.75 g) was added to a
scintillation vial. Fenofibrate (Sigma) (1.0g) was then
added to the vial and mixed until it was completely
20 dissolved. To this solution was added Cremophor RH 40
(BASF) (2.0 gm). The resulting solution was heated to about
45-50°C and mixed until a clear solution was obtained. To
this solution was added polyethylene glycol 3350 (Union
Carbide) (0.25 g) and the resulting mixture was stirred
25 until a clear solution was obtained. The resulting solution
(0.67 g) was filled into hard gelatin capsules while the
solution was still warm and in a liquid state. Each capsule
contained 67 mg of fenofibrate.

Example 3

Pravastatin 1.0g
Myvacet 9-08 6.0g
5 Propylene glycol Laurate 1.0g
Vitamin E TPGS 2.0g

Add Myvacet 9-08 in a scintillation vial. Add propylene glycol laurate and mix until uniform. Add the pravastatin
10 and mix until uniformly dispersed. Heat the solution to approximately 45 -50C and add Vitamin E TPGS and mix until uniformly dispersed. Fill an amount of the pre-mix into capsules, sufficient to deliver the desired dose.

15 Example 4

Capsules prepared by the process described in Examples 1 and 2 and from a commercial fenofibrate composition, Lipanthyl 67M (Groupe Fournier) (Reference), were
20 administered to a group of dogs at a dose of 67 mg fenofibrate/dog (one capsule/dog). The plasma concentrations of fenofibric acid were determined by HPLC. Concentrations were normalized to a 6.7 mg/kg dose in each dog. Figures 1 and 2 presents the resulting data in graph
25 form. The results provided as mean \pm SD, n=6, were as follows:

Figure 1

Lipanthyl 67M (Reference):

30 $C_{max} = 1.88 \pm 0.97$ mcg/ml

$T_{max} = 1.6 \pm 0.9$ hr

$t_{1/2} = 4.5$ hr

$AUC (0-24) = 11.08 \pm 9.42$ mcg•hr/ml

Capsule of Example 1:

$C_{max} = 6.60 \pm 1.60$ mcg/ml

$T_{max} = 1.3 \pm 0.5$ hr

5 $t_{1/2} = 4.4$ hr

$AUC (0-24) = 27.68 \pm 5.62$ mcg•hr/ml

Figure 2

Lipanthyl 67M (Reference):

10 $C_{max} = 1.88 \pm 0.97$ mcg/ml

$T_{max} = 1.6 \pm 0.9$ hr

$t_{1/2} = 4.5$ hr

$AUC (0-24) = 11.08 \pm 9.42$ mcg•hr/ml

15 Capsule of Example 2:

$C_{max} = 7.74 \pm 2.27$ mcg/ml

$T_{max} = 0.7 \pm 0.3$ hr

$t_{1/2} = 7.5$ hr

$AUC (0-24) = 26.27 \pm 8.11$ mcg•hr/ml

Claims

1. A composition comprising a semi-solid formulation of a lipid-regulating agent, one or more liquid components,
5 and one or more solid or semi-solid components.
2. A composition of claim 1 wherein said lipid-regulating agent is a fibrate.
- 10 3. A composition of claim 2 wherein said fibrate is fenofibrate.
4. A composition of claim 1 wherein said lipid-regulating agent is a statin.
15
5. A composition of claim 4 wherein said statin is prevastatin.
6. A composition of claim 4 wherein said statin is
20 atorvastatin.
7. A composition of claim 1 wherein at least one or more of said liquid components is an oily or non-aqueous solvent selected from the group consisting of
25 acetylated monoglycerides, propylene glycol fatty acid esters, and unsaturated polyglycolysed glycerides.
8. A composition of claim 1 wherein one or more of said liquid components is a non-ionic surfactant selected
30 from the group consisting of mono fatty acid esters of polyoxyethylene sorbitan, anionic surfactants, polyoxyethylene castor oil derivatives, and Vitamin E TPGS (d-alpha -tocopheryl succinate).

9. A composition of claim 1 wherein at least one or more of said solid or semi-solid components is a semisolid pharmaceutical or solid pharmaceutical excipient selected from the group consisting of polypropylene glycol; polyethylene glycol, polyoxyethylene castor oil derivatives, polyoxyethylene glycerol oxystearate, saturated polyglycolized glycerides, polyethylene polypropylene glycol and Vitamin E TPGS (d-alpha - tocopheryl polyethylene glycol 1000 succinate).
10. A delivery system comprising a composition of claim 1.
11. A delivery system of claim 10 wherein said delivery system is a capsule.
12. A method of treating hyperlipidemia comprising the administration of a composition of claim 1 to a patient.
13. A method of treating hyperlipidemia comprising the administration of a composition of claim 3 to a patient.
15. A method of treating hyperlipidemia comprising the administration of a composition of claim 11 to a patient.

1/1

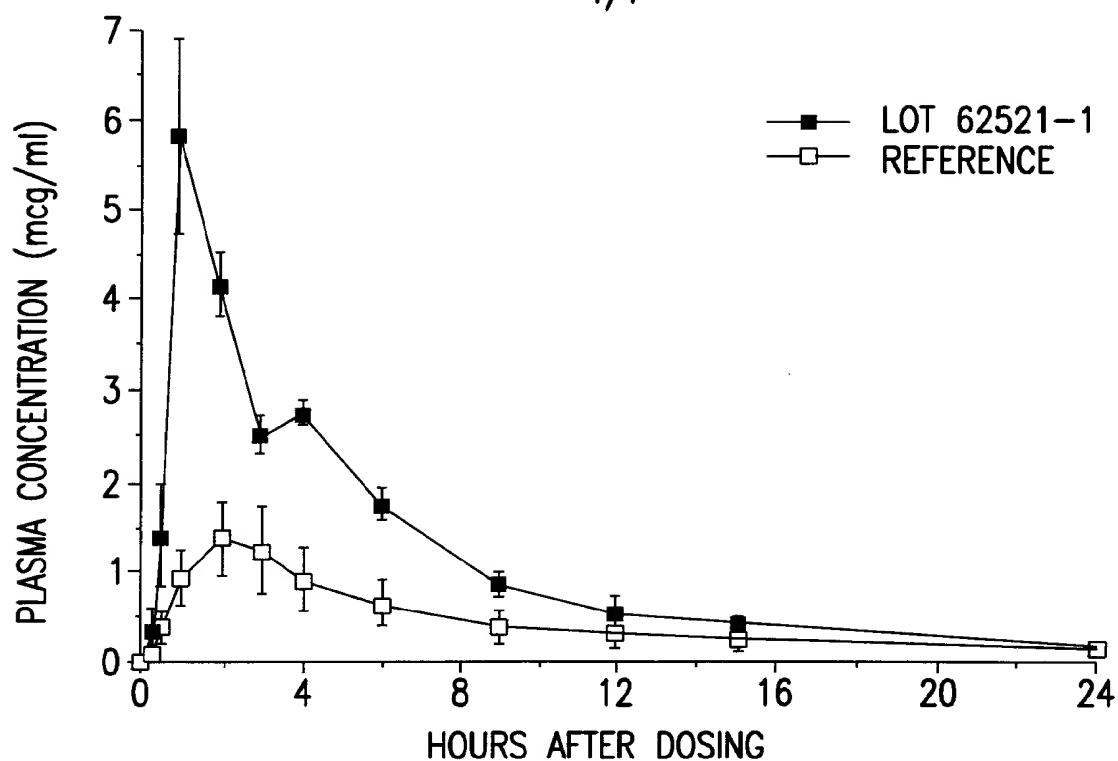


FIG.1

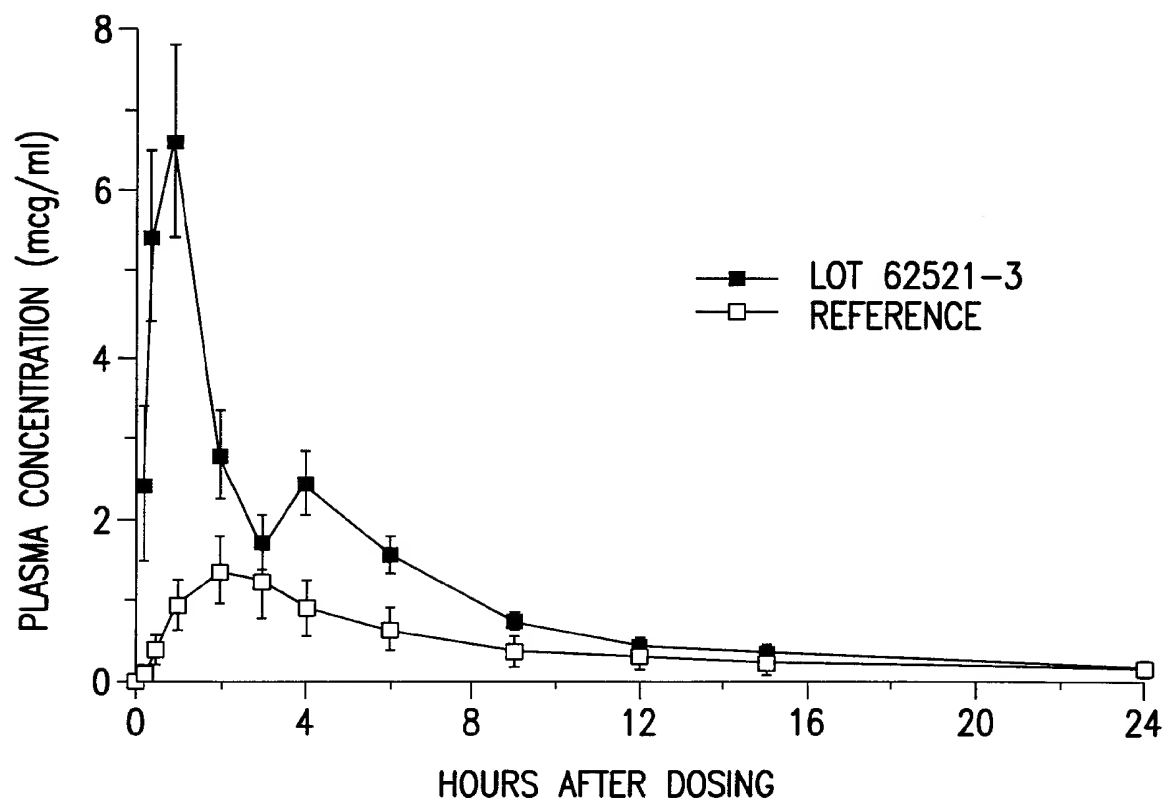


FIG.2

SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/15717

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61K9/48 A61P3/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, BIOSIS, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 590 864 A (LILLY INDUSTRIES LTD) 10 June 1981 (1981-06-10) page 1, line 4 - line 19 page 2, line 23 - line 63; claims; example 1 ---	1,2, 10-13,15
X	US 5 645 856 A (LACY JONATHAN ERNEST ET AL) 8 July 1997 (1997-07-08) column 1, line 4 - line 7 column 3, line 56 -column 4, line 14 column 4, line 36 -column 5, line 51 column 6, line 34 -column 7, line 55 column 8, line 45 -column 9, line 14 column 12, line 22 - line 23 column 12, line 54 -column 13, line 7 column 13, line 47 - line 57 claims 1-8,15-17; example 7 --- -/--	1-3,7-11

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

20 September 2000

Date of mailing of the international search report

04/10/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Marttin, E

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/15717

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>DATABASE CHEMABS 'Online! CHEMICAL ABSTRACTS SERVICE, COLUMBUS, OHIO, US; BEN-AMOR, A. ET AL: "Augmentation of the bioavailability of a hypolipemic agent for incorporation into a liquid-containing gel" retrieved from STN Database accession no. 112:62494 XP002144219 abstract & CONGR. INT. TECHNOL. PHARM., 5TH (1989), VOLUME 3, 190-9 PUBLISHER: ASSOC. PHARM. GALENIQUE IND., CHATENAY MALABRY, FR. , XP000929723 page 190, paragraph 1 page 190, last paragraph -page 191, paragraph 2 page 191, paragraph 5 page 193, paragraph 2 - last paragraph page 195, paragraph 1 page 197, last paragraph ---</p>	1,3,7, 10,11
P,X	<p>WO 99 29300 A (MISHRA AWADHESH K ;PARIKH INDU (CA); MOUSSA ISKANDAR (CA); RTP PHA) 17 June 1999 (1999-06-17) page 1, line 1 - line 2 page 5, paragraph 2 -page 8, paragraph 1 page 9, paragraph 2 -page 10, paragraph 1; claims; examples ---</p>	1-3, 8-13,15
P,X	<p>WO 99 36060 A (TRESPIDI LAURA A ;DESAI ASHOK J (US); MEYER GLENN A (US); CLARK CH) 22 July 1999 (1999-07-22) page 3, line 19 -page 4, line 6 page 5, line 27 - line 28 page 8, line 9 - line 20 page 9, line 3 - line 10 page 9, line 19 - line 26 page 14, line 7 - line 10 claims 1-11,13-15,20-25,28-36; examples 7,8,11-14 ---</p>	1,2,4-6, 8-13,15
P,X	<p>EP 0 998 927 A (FUJIREBIO KK) 10 May 2000 (2000-05-10) page 2, paragraph 2 - paragraph 4 page 2, last paragraph -page 3, paragraph 1; claims; examples 2,3,10-12,14 ---</p>	1,7-13, 15
	<p>---</p> <p>-/--</p>	

INTERNATIONAL SEARCH REPORT

Int. l. Application No

PCT/US 00/15717

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E, L	<p>WO 00 37057 A (ABBOTT LAB) 29 June 2000 (2000-06-29) Document so quoted for its casting doubt on the validity of the convention-priority claim. page 1, line 7 - line 8 page 3, line 11 - line 18 page 4, line 4 - last line; claims; examples</p> <p>-----</p>	1-13, 15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/15717

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 1590864 A	10-06-1981	CA 1135623 A DE 2838387 A	16-11-1982 31-10-1979
US 5645856 A	08-07-1997	AU 686767 B AU 1897495 A CA 2185347 A EP 0750495 A WO 9524893 A JP 10503750 T US 6096338 A	12-02-1998 03-10-1995 21-09-1995 02-01-1997 21-09-1995 07-04-1998 01-08-2000
WO 9929300 A	17-06-1999	AU 1809499 A AU 1817499 A WO 9929316 A	28-06-1999 28-06-1999 17-06-1999
WO 9936060 A	22-07-1999	AU 2117399 A	02-08-1999
EP 0998927 A	10-05-2000	JP 2000198783 A	18-07-2000
WO 0037057 A	29-06-2000	NONE	